

# APPENDIX

1. A locking system implemented on a distributed file system where clients directly access data on storage devices via a storage area network and a file server provides metadata for said data and manages revocation and granting of locks of said lock system, said lock system comprising:

a consumer lock, said consumer lock granted to one or more readers and said consumer lock allowing a reader granted said consumer lock to read a file comprising one or more blocks ~~block~~ of data;

a producer lock, said producer lock granted to a single writer and said producer lock allowing a ~~said~~ writer granted said producer lock to ~~change~~ update said file comprising one or more blocks ~~block~~ of data, and

wherein upon completion of said writer changing update ~~said block of data~~, said writer releases said producer lock, and upon release of said producer lock, said updated file being published, with said reader granted said readers having a consumer lock associated with said updated file being is-notified regarding said updates ~~said block of data has changed~~.

2. A locking system implemented on a distributed file system where clients directly access data on storage devices via a storage area network and a file server provides metadata for said data and manages revocation and granting of locks of said lock system as per claim 1, wherein ~~said block of data~~ file is changed ~~updated~~ by writing updated ~~changed~~ blocks of data to a physical storage location different than where said block of data is stored.

3. A locking system implemented on a distributed file system where clients directly access data on storage devices via a storage area network and a file server provides metadata for said data and manages revocation and granting of locks of said lock system as per claim 2, wherein,

~~said notification informs said reader of said updated data location~~after said publication of said file, said system notifies readers granted a consumer lock for said file regarding location of said updated file.

4. A locking system implemented on a distributed file system where clients directly access data on storage devices via a storage area network and a file server provides metadata for said data and manages revocation and granting of locks of said lock system as per claim 32, wherein ~~said notification causes a cached copy of said block of data~~file is held in a cache of said reader to be invalidated and said cached copy is updated at a finer granularity with respect to changed blocks in said physical storage.

5. A locking system implemented on a distributed file system where clients directly access data on storage devices via a storage area network and a file server provides metadata for said data and manages revocation and granting of locks of said lock system as per claim 23, wherein reads performed on said block of data by said reader after receiving said notification are performed by reading said updated file data from at said updated data notified location.

6. A locking system implemented on a distributed file system where clients directly access data on storage devices via a storage area network and a file server provides metadata for said data and manages revocation and granting of locks of said lock system as per claim 2, wherein said reader continues to read said ~~block of data~~file from the physical storage location ~~said block of data is stored~~ while said writer is writing said updated data to said different physical storage location.

7. A locking system implemented on a distributed file system where clients directly access data on storage devices via a storage area network and a file server provides metadata for said data and manages revocation and granting of locks of said lock system as per claim 1, wherein said writer writes data to storage devices physically separated from a storage device located on said file system server.

8. A locking system implemented on a distributed file system where clients directly access data on storage devices via a storage area network and a file server provides metadata for said data and manages revocation and granting of locks of said lock system as per claim 7, wherein said writer writes data to said physically separate storage devices ~~via~~ that are part of a storage area network.

9. A locking system implemented on a distributed file system where clients directly access data on storage devices via a storage area network and a file server provides metadata for said data and manages revocation and granting of locks of said lock system as per claim 7, wherein said storage device located on said file system server stores metadata.

10. A locking system implemented on a distributed file system where clients directly access data on storage devices via a storage area network and a file server provides metadata for said data and manages revocation and granting of locks of said lock system as per claim 7, wherein said physically separate storage devices cache data for read operations.

11. A locking system implemented on a distributed file system where clients directly access data on storage devices via a storage area network and a file server provides metadata for said

data and manages revocation and granting of locks of said lock system as per claim 1, wherein said reader is a web server.

12. A locking system implemented on a distributed file system where clients directly access data on storage devices via a storage area network and a file server provides metadata for said data and manages revocation and granting of locks of said lock system as per claim 1, wherein said writer is a database management system.

13. (cancelled)

14. A locking system implemented on a distributed file system where clients directly access data on storage devices via a storage area network and a file server provides metadata for said data and manages revocation and granting of locks of said lock system as per claim 1, wherein said lock system is implemented on a system where said reader and said writer access data directly from storage devices via a storage area network and said readers and said writers access metadata from said file server via a data network separate from said storage area network.

15. A locking system implemented on a distributed file system where clients directly access data on storage devices via a storage area network and a file server provides metadata for said data and manages revocation and granting of locks of said lock system as per claim 1, wherein said lock system is implemented in a distributed file system which utilizes multiple locking systems for data where the locking system used for a particular block of data is dependent on what application utilizes said particular block of data and the locking system utilized for the

particular block of data is indicated by the metadata corresponding to said particular block of data.

16. A method of updating a ~~data-block~~file comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~file data-block~~, and a producer lock, said producer lock granted exclusively to a single writer to allow said writer to update said ~~data-block~~file, said method comprising:

receiving a request from ~~said a~~ writer to grant ~~said an exclusive~~ producer lock ~~to~~  
~~said writer~~;

granting said exclusive producer lock to said writer;

receiving a producer lock release message, said producer lock release message  
being received after said writer completes updating ~~said file of said data-block~~; and

publishing said updated file and sending an update message to said readers  
holding said consumer lock, said update message notifying said readers ~~said data-block has been~~  
~~updated~~regarding said update.

17. A method of updating a ~~data-block~~file comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said file data-block, and a producer lock, said producer lock granted exclusively to a single writer to allow said writer to update said ~~data-block~~file as per claim 16, wherein said ~~data-block~~file is updated by writing updated-changed blocks of data to a different physical storage location than where said data block is stored.

18. A method of updating a ~~data-block~~file comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~file~~data-block, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block~~file as per claim 17, wherein said update message informs said readers ~~of said updated data location~~granted a consumer lock for said file regarding location of said updated file.

19. A method of updating a ~~data-block~~file comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~file~~data-block, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block~~file as per claim ~~18~~17, wherein said update message causes a cached copy of said ~~data-block~~file held in a cache of said readers ~~to be invalidated~~to be updated at a finer granularity with respect to changed blocks of said file in said physical storage.

20. A method of updating a ~~data-block~~file comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~file~~data-block, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block~~file as per claim 17, wherein reads performed on said data block by said readers after receiving said update message are performed by reading said updated ~~data~~file from ~~at~~ said ~~updated data~~notified location.

21. A method of updating a ~~data-block~~file comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers

to allow said readers to read said ~~file~~data-block, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block-file~~ as per claim 17, wherein said reader continues to read said ~~data-block~~file from the physical storage location ~~said data-block is stored~~ while said writer is writing said updated ~~data~~file to said different physical storage location.

22. A method of updating a ~~data-block~~file comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~file~~data-block, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block-file~~ as per claim 16, wherein said writer writes data to storage devices physically separated from a storage device located on said file system server.

23. A method of updating a ~~data-block~~file comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~file~~data-block, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block-file~~ as per claim 22, wherein said writer writes data to said physically separate storage devices via that are part of a storage area network.

24. A method of updating a ~~data-block~~file comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~file~~data-block, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block-file~~ as per claim 22, wherein said storage device located on said file system server stores metadata.



25. A method of updating a ~~data-block~~file comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~file~~data-block, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block~~file as per claim 22, wherein said physically separate storage devices cache data for read operations.

26. A method of updating a ~~data-block~~file comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~file~~data-block, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block~~file as per claim 16, wherein said reader is a web server.

27. A method of updating a ~~data-block~~file comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~file~~data-block, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block~~file as per claim 16, wherein said writer is a database management system.

28. A method of updating a ~~data-block~~file comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~file~~data-block, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block~~file as per claim 16, wherein said lock system is implemented on a system where said readers and said writer access data directly from

storage devices via a storage area network and said readers and said writers access metadata from said file server via a data network separate from said storage area network.

29. A method of updating a ~~data-block~~file comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~file~~data-block, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block~~file as per claim 16, wherein said method is implemented in a distributed file system which utilizes multiple locking systems for data where the locking system used for a particular block of data is dependent on what application utilizes said particular block of data and the locking system utilized for the particular block of data is indicated by the metadata corresponding to said particular block of data.

30. A method of updating a ~~data-block~~file comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~data-block~~file, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block~~file, said method comprising:

sending a request for said producer lock;

receiving said producer lock;

updating said ~~data-block~~file comprising one or more data blocks;

releasing said producer lock after said updating is completed; and

publishing said updated file.

31. A method of updating a ~~data-block~~file comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers

to allow said readers to read said ~~data-block~~file, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block~~file as per claim 30, said method further comprising:

sending an update message to said readers granted said consumer lock after said ~~releasing-publishing~~ step, said update message notifying said readers said ~~data-block~~file has been updated.

32. A method of updating a ~~data-block~~file comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~data-block~~file, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block~~file as per claim 30, wherein said updating step comprises writing ~~updated~~changed blocks of data to a different physical storage location than where said data block is stored.

33. (cancelled)

34. A method of updating a ~~data-block~~file comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~data-block~~file, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block~~file as per claim 3332, wherein said ~~notification~~update message informs said readers granted a consumer lock for said file regarding location of said updated file~~data location~~.

35. A method of updating a ~~data-block-file~~ comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~data-blockfile~~, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block-file~~ as per claim 34~~32~~, wherein said ~~notification-update message~~ causes a cached copy of said data block held in a cache of said readers to be ~~invalidated~~ updated at a finer granularity with respect to changed blocks in said physical storage.

36. A method of updating a ~~data-block-file~~ comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~data-blockfile~~, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block-file~~ as per claim 33, wherein reads performed on said data block by said readers after receiving said ~~notification-update message~~ are performed by reading said updated ~~data-file~~ from said ~~updated data-notified~~ location.

37. A method of updating a ~~data-block-file~~ comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~data-blockfile~~, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block-file~~ as per claim 33, wherein said readers continue to read said ~~data-blockfile~~ from the physical storage location ~~said block of data is stored~~ while said writer is writing said-updated data to said different physical storage location.

38. A method of updating a ~~data-block-file~~ comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~data-blockfile~~, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block\_file~~ as per claim 30, wherein said writer writes data to storage devices physically separated from a storage device located on said file system server.

39. A method of updating a ~~data-block-file~~ comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~data-blockfile~~, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-blockfile~~, as per claim 38, wherein said writer writes data to said physically separate storage devices ~~via~~ that are part of a storage area network.

40. A method of updating a ~~data-block-file~~ comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~data-blockfile~~, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block\_file~~ as per claim 30, wherein said storage device located on said file system server stores metadata.

41. A method of updating a ~~data-block-file~~ comprising one or more data blocks in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~data-blockfile~~, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block\_file~~ as per claim 38, wherein said physically separate storage devices cache data for read operations.

42. A method of updating a ~~data-block file comprising one or more data blocks~~ in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~data-block file~~, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block file~~ as per claim 30, wherein said reader is a web server.

43. A method of updating a ~~data-block file comprising one or more data blocks~~ in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~data-block file~~, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block file~~ as per claim 30, wherein said writer is a database management system.

44. A method of updating a ~~data-block file comprising one or more data blocks~~ in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~data-block file~~, and a producer lock, said producer lock granted to a writer to allow said writer to update said ~~data-block file~~ as per claim 30, wherein said method is implemented on a system where said readers and said writer access data directly from storage devices via a storage area network and said readers and said writers access metadata from said file server via a data network separate from said storage area network.

45. A method of updating a ~~data-block file comprising one or more data blocks~~ in a distributed file system including a consumer lock, said consumer lock granted to multiple readers to allow said readers to read said ~~data-block file~~, and a producer lock, said producer lock

granted to a writer to allow said writer to update said ~~data block file~~ as per claim 30, wherein said method is implemented in a distributed file system which utilizes multiple locking systems for data where the locking system used for a particular block of data is dependent on what application utilizes said particular block of data and the locking system utilized for the particular block of data is indicated by the metadata corresponding to said particular block of data.

- 46. (cancelled)
- 47. (cancelled)
- 48. (cancelled)
- 49. (cancelled)
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- 51. (cancelled)
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- 53. (cancelled)
- 54. (cancelled)
- 55. (cancelled)
- 56. (cancelled)
- 57. (cancelled)

58. A distributed computing system including a file system handling cache coherency and data consistency providing ~~multiple~~-quality of service through a locking protocols, said system comprising:

a server, said server connected to at least one client of said distributed computing system via a first data network, said server serving file metadata to said client upon said client

accessing a file stored in said distributed computing system, said server managing data consistency and cache coherency through ~~multiple said~~ locking protocols ~~designed to support different application's data consistency and cache coherency needs;~~

a storage device connected to said client via a second data network, said storage device storing file data;

wherein one of said ~~multiple~~ locking protocols is ~~assigned to a file based upon which application utilizes said file and said locking protocol assigned to said file is indicated via said file metadata~~ comprises the following locks:

a consumer lock, said consumer lock granted to one or more readers and said consumer lock allowing a reader granted said consumer lock to read a file comprising one or more blocks of data; and

a producer lock, said producer lock granted to a single writer and said producer lock allowing said writer granted said producer lock to update said file comprising one or more blocks of data, and upon completion of said update, said writer releases said producer lock, and upon release of said producer lock, said updated file being published, with readers having a consumer lock associated with said updated file being notified regarding said update..

59. (cancelled)

60. (cancelled)

61. A distributed computing system including a file system handling cache coherency and data consistency providing ~~multiple~~ quality of service through a locking protocols, as per claim-



6058, wherein said ~~block of data~~file is changed by writing ~~updated~~ changed blocks of data to a physical storage location different than where said block of data is stored.

62. A distributed computing system including a file system handling cache coherency and data consistency providing ~~multiple~~ quality of service through a locking protocols, as per claim 61, wherein, after said publication of said file, said system notifies readers granted a consumer lock for said file regarding location of said updated file ~~said notification informs said reader of said updated data location.~~

63. A distributed computing system including a file system handling cache coherency and data consistency providing ~~multiple~~ quality of service through a locking protocols, as per claim 62, wherein ~~said notification causes a cached copy of said block of data~~ file held in a cache of said reader to be invalidated is updated at a finer granularity with respect to changed blocks in said physical storage.

64. A distributed computing system including a file system handling cache coherency and data consistency providing ~~multiple~~ quality of service through a locking protocols, as per claim 61, wherein reads performed on said ~~block of data~~ by said reader after receiving said notification file are performed by reading ~~said updated data from said updated data notified~~ location.

65. A distributed computing system including a file system handling cache coherency and data consistency providing ~~multiple~~ quality of service through a locking protocols, as per claim 61, wherein said reader continues to read said ~~block of data~~ file from the physical storage

location ~~said block of data is stored~~ while said writer is writing ~~said updated data file~~ to said different physical storage location.

66. A distributed computing system including a file system handling cache coherency and data consistency providing ~~multiple~~ quality of service through a locking protocols, as per claim 60, wherein said reader is a web server.

67. A distributed computing system including a file system handling cache coherency and data consistency providing ~~multiple~~ quality of service through a locking protocols, as per claim 60, wherein said writer is a database management system.

68. (cancelled)